PATENT SPECIFICATION

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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in or relating to Pulse Ionisation Chambers.

We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pulse ionisation chambers and like devices for determining ionising radiations.

As will be known one form of such chambers extensively used in nuclear reactor control systems is a neutron sensitive fission chamber adapted to provide a pulsed output from which a pulse count gives a measure of the neutron flux. This counter includes a gas-filled chamber having electrodes which in use are maintained at a sufficient potential difference that electrons arising from the ionisation of the filling gas within the chamber, whose filling gas has been ionised as a result of radiation, are induced under the electric field to migrate towards the collector electrode with a certain drift velocity. The movement of electrons towards the electrode gives rise to electric pulses which pass, via the collector electrode, to the counting equipment. As is also known, a neutron sensitive pulse counting channel will only cover a limited range of neutron flux levels and the fission chamber as presently designed limits the top of this range by the duration of pulse generated by the counter.

In order to achieve faster collection times, it has been proposed hitherto to provide a chamber employing, as a chamber filling gas, a mixture comprising a rare gas (e.g. argon) together with an additive in the form of a polyatomic gas, such as carbon dioxide or methane. It is currently supposed that this additive exerts a moderating effect on the agitation energy of an electron in the filling gas. As the mean free path of an electron depends on its agitation energy (the known Ramsauer effect) and drift velocity depends upon mean path, it is possible to increase the drift velocity in this way thereby giving faster collection times.

Such a filling gas suffers from the disadvantage that it is liable to radiation damage in high neutron fluxes with consequential change in drift velocity characteristics and, although the gas mixture, as aforesaid, may be of some value if the counter is not immersed in very high neutron fluxes for long periods, the possibility that this damage may occur remains a limitation in the exploitation of this technique and deters its acceptance for wide use.

The present invention is based on the concept that by a judicious selection of an alternative rare gas as the additive in the proper proportion, the agitation energy of an electron in the mixture of gases may be similarly influenced so as to produce a similarly fast collection time and yet avoid the possibility of radiation damage.

The invention provides therefore a method of measuring neutron flux, which resides in placing within the flux a pulse ionisation chamber containing a mixture of rare gases in proportions selected such that an optimisation of fission fragment stopping power and electron drift velocity in the mixture is obtained, applying an ionising potential to the chamber electrodes, collecting pulses on the cathode and utilising the collected pulses as a measure of flux.

Preferably the fission chamber is filled with a gas mixture including helium and xenon.

The particular mixture to be used in any given situation depends partly upon its ability to arrest fission fragments originating from fission of the chamber coating (i.e. its fission fragment stopping power) and thereby to retain the energy of the fission fragments in the filling gas and partly upon the desired electron drift velocity. Xenon is perhaps the best gas from the point of view of stopping power, it having the highest mass number. Krypton and argon are less suitable. Neon is rejected on account of its somewhat low dielectric strength — it is thus prone to electrical breakdown, whilst radon is unstable.

A pulse fission chamber was filled with helium in admixture with varying proportions of xenon and the collection times measured. The result of a series of measurements enabled the curve shown in the Figure to be plotted. This shows that with helium as one rare gas a 25 per cent addition of xenon produced the fastest collection time. This time was half that observed with an argon filled chamber under similar conditions.

Alternative gas mixtures for giving a collection time faster than the usual argon filled chamber are:

(1) Helium and krypton
(2) Helium and argon

The optimum proportions are easily discernible from observations made with appropriately filled chambers.

WHAT WE CLAIM IS:—

1. A method of measuring neutron flux which resides in placing within the flux a fission chamber containing a mixture of rare gases in proportions selected such that an optimisation of fission fragment stopping power and electron drift velocity in the mixture is obtained, applying an ionising potential to the chamber electrodes, collecting pulses on the cathode and utilising the collected pulses as a measure of flux.

2. A fission chamber for use in the method claimed in claim 1 in which the gas filling of the chamber is a mixture containing helium and xenon.

3. A fission chamber as claimed in claim 2 in which helium and xenon are present in proportions 75% and 25% respectively.

4. A fission chamber for use in the method claimed in claim 1 in which the gas filling of the chamber is a mixture of helium and krypton.

5. A fission chamber for use in the method claimed in claim 1 in which the gas filling is a mixture of helium and argon.

6. A fission chamber for use in the method claimed in claim 1 and substantially as herein described.

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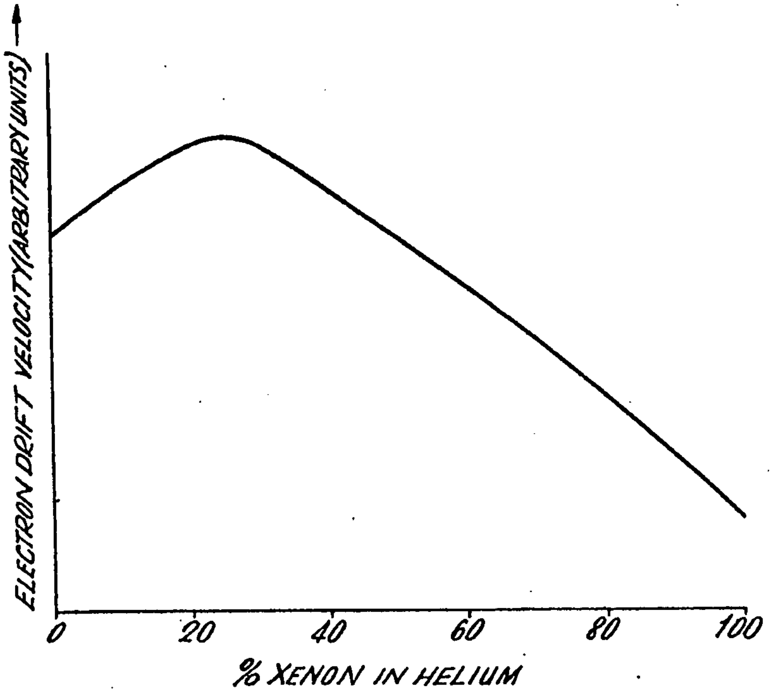
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